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Signed

Dated 21 December 2004

GB0324349.0

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of:-

INTELLIGENT ELECTRICS (INTELLECTUAL PROPERTY) LIMITED
Sunny Acres
Bridport Road
Winterbourne Steepleton
DORCHESTER
DT2 9DX
United Kingdom
ADP No. 08966152002]

GB0324349.0

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of:-

INTELLIGENT ELECTRICS (DISTRIBUTORS) LIMITED
Incorporated in the United Kingdom
Sunny Acres, Bridport Road
Winterbourne Steepleton
Dorchester, DT2 9DX
United Kingdom
ADP No. 08948820001

(1977 ACT) APPLICATION FILED 4/10/04

Patents Form 1/77

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2. Patent application number *(The Patent Office will fill in this part)* 0324349.0

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

INTELLIGENT ELECTRICS LIMITED
SUNNY ACRES
BRIDPORT ROAD
WINTERBOURNE STEEPLETON
DT2 9DX

APPLICATION FILED (1977 ACT) 8/9/04

Patents ADP number *(if you know it)* 8598310003

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

ENERGY SAVING

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

PROSPECT ASSOCIATES
PROSPECT CENTRE
17b CAMBRIDGE ROAD
WEYMOUTH
DT4 9TJ

Patents ADP number *(if you know it)* ~~07482787001~~ 7640576002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
~	~	~

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
~	~

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
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See note (d))

YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	11
Claim (s)	4
Abstract	1
Drawing (s)	2 only

10. If you are also filing any of the following, state how many against each item.

Priority documents	–
Translations of priority documents	–
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	1
Request for preliminary examination and search *(Patents Form 9/77)*	–
Request for substantive examination *(Patents Form 10/77)*	–
Any other documents *(please specify)*	–

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 18/10/03

12. Name and daytime telephone number of person to contact in the United Kingdom MICHAEL WHELLER 01305 780565

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ENERGY SAVING

This invention concerns the control of electrical apparatus remotely, especially but not exclusively for reducing the power consumed thereby.

Many premises, such as factories, shops and offices, contain electrical apparatus which needs to be on for only a portion of each day. A cold drinks dispenser in a factory, for instance, needs to be on (cooling the drinks it contains) during the hours when the factory is in an open state – that is, when staff are working on the premises; but such a cold drinks dispenser does not need to be on when the factory is in a closed state – that is, when it is unoccupied, say at night. The same applies, of course, to hot drinks dispensers and a wide range of other apparatus including air conditioning units, space heaters, water heaters, fans, lights and so forth.

Energy and costs are saved if such items of apparatus are switched off when not required. Two known ways of doing this are (a) to appoint somebody to go around the premises and switch the apparatus on and off as appropriate and (b) to connect the apparatus to the power supply by means of time switches. Both of these approaches have problems, as will now be explained.

Appointing somebody to switch the apparatus on and off may be relatively expensive, especially if the person appointed is of a management grade (it being currently common in business for senior staff to be first to arrive and last to leave). It draws that person away from normal duties, which is contrary to

good management practice. It calls for additional organisation, particularly in covering for sickness and holidays. And it presents a practical problem in that many kinds of apparatus such as drinks dispensers are deliberately arranged to shield access to their connections with the power supply, for safety and to deter tampering. Finally, the person appointed may become neglectful of the task over time, especially if nobody else notices whether or not the task is being properly performed.

The problems outlined above in relation to manual switching may be overcome by the use of time switches, but at the cost of introducing other problems. First, time switches inherently work on a routine, changing from on to off at set times of the day, and thus they do not offer any flexibility with regard to use of premises: they do not, for instance, adapt to early opening or late closing. In any event, time switches need to be reset twice a year, when clocks are seasonally adjusted. Also, unless the time switch is sophisticated enough (and therefore expensive) to be programmable for a whole week, it will treat weekends and holidays as normal working days and an appliance connected to it will be switched on even though the premises are closed.

The various problems of manual switching and time switching in a building may be addressed by remote control systems. A system of this kind, with switching controlled by registering the open or closed state of the building, is disclosed in our copending European patent application EU 01 921 646.4. Various modifications of this system, and their application to *inter alia* heating

control and lighting control, are disclosed in our copending applications GB 0211958.4, GB 0306940.8 and GB 0318380.3.

It is an object of the present invention to provide further improvements in the remote control of electrical switching.

According to the invention there is provided a system for controlling electrical apparatus remotely in response to changes of a variable, which system comprises a sensor to sense the variable, a controller operatively associated with the sensor and including a radio transceiver operative to transmit a control signal when the variable changes and to transmit and receive system management signals, and a responder arranged remote from the transmitter and including a radio transceiver operative to receive the control signal and to receive and transmit system management signals.

The sensor may be a passive infra-red (PIR) or microwave device arranged to sense the presence or absence of users of the apparatus. Thus, for instance, the system may automatically switch lights on when people enter a room and switch them off when they leave.

Otherwise the sensor may respond to an output from an intruder alarm for premises containing the apparatus. This allows lights and/or other unwanted apparatus to be switched off automatically when premises are vacated, eg at night, and switched on again the next day.

The variable sensed by the sensor may be a natural variable such as ambient temperature, whereby the system may be used to control heaters, or

ambient light level, whereby artificial light may be adjusted to keep the overall lighting substantially constant, which is particularly useful in sports facilities. Another kind of lighting control possible with the invention is to switch on emergency lights in the events of mains failure.

Usually the system will comprise a plurality of responders, and each of these may be arranged to function as a repeater for control signals so that the system can function satisfactorily over an extended range.

Preferably the system management signals include identity signals transmitted by the or each transponder and received by the controller, and the controller may include a status array recording the proper status of a plurality of said responders. With this arrangement the controller may include reset means operative to check the actual status of each responder against the recorded status and to indicate any discrepancy.

The controller is preferably operative to switch controlled apparatus on and off alternatively by transmitting a global switch control signal associated with responder identity signals followed by status request signals to the responders seriatim. Then each responder may respond to the status request signal by transmitting an actual status signal for receipt by the controller and comparison with the record in the status array. If for any responder there is a discrepancy between the actual status and the record, the controller may transmit a correction signal to that responder. And preferably the corrected controller

transmits a confirmation signal to the controller when it is corrected, failing which the controller records the responder as faulty.

The system may include a computer interface. This may (a) enable any responder to be specifically responsive to a defined controller, (b) allow the system to be partitioned into zones, (c) allow a responder to be given an individual feature (for instance, inhibition of its repeater facility) and/or (d) provide an operative connection between the system and a building management system.

To simplify manufacture and reduce costs, the radio transceiver of the controller is preferably the same as the radio transceiver of the or each responder.

The invention will now be described by way of example only with reference to the accompanying schematic drawings, in which –

Figure 1 outlines a system for controlling electrical apparatus remotely according to the invention and comprising a controller and a plurality of responders;

Figure 2 provides an overview of the modular design of the system of Figure 1;

Figure 3 illustrates the application of the invention to emergency lighting control; and

Figure 4 shows how the invention may respond to power failure.

Referring first to Figure 1, this shows a room 10 equipped with two overhead lights 12. Formerly, the lights 12 were operable from either of two wall switches located at opposite ends of the room 10, but despite the apparent convenience of this arrangement the lights 12 were often left on. Accordingly the lights 12 now operate under the control of a PIR sensor 14 arranged to detect any person in the room 10. When this happens, a controller 16 (to be described in more detail hereinafter) associated with the detector 14 transmits a radio-frequency control signal. The control signal is received by a responder 18 (also to be described in more detail hereinafter) associated with each light 12 and causes a switch in the power supply to be closed automatically, switching the lights 12 on. When the detected person leaves the corridor 10, the lights 12 are automatically switched off. Thus power is saved.

A particular advantage of the arrangement of Figure 1 is that the lights 12 may be provided with automatic operation without expensive rewiring, since the detector 14 can be located for best visibility without concern for the location of the lights 12.

The controller 16 and the responders 18 will now be described in more detail with reference to Figure 2. Each includes a radio module 20 comprising a transceiver 22 and a processor 24. The transceiver 22 is an RF211 radio transceiver IC operating at 868MHz and the processor 24 is an AT mega 16 microcontroller IC, both of which items are supplied by Atmel, but those skilled in the science will appreciate that other units may be used. An ISP programmer

(STK500) 26 is operatively associated with the processor 24. The controller 16 and the responders 18 each also include a common power supply unit 28 arranged to deliver 3.3V from either electrical mains 30 or battery 32 supply. The system is operated and monitored though one or more of keypad 34, a control button panel 36, a light-emitting diode (LED) indicator 38, a liquid crystal display (LCD) 40 and a computer interface 42 connected to the radio module 20 by way of an input/output device 44. The PIR sensor 14 (see also Figure 1) is connected to the radio module 20 by way of the input/output device 44. Finally, each responder 18 includes a 16A relay unit 46 in the power supply to the lights 12 (Figure 1). Thus the lights 12 are switched on and off according to the presence or absence of people in the room 10, as sensed by the sensor 14.

Two important additional features of the invention may be noted at this point. First, the system may be arranged to adjust lights progressively, rather than simply switching them on and off, as will be described in more detail hereinafter. Second, the relays 46 may be used to control apparatus other than lights and as described in our copending patent application EU 01 921 646.4 may be incorporated in electrical socket outlets, extensions leads etc for general use.

As well as simplifying manufacture and reducing system costs, the use of transceivers in both the controller 16 and the responders 18 (Figure 1) enables management signals to be interchanged so that the system is reliable and substantially immune to interference, as will now be described.

The controller 16 includes a reset button (not detailed in Figure 1 but which, for security, is best located within a casing for the controller 16 and accessed by opening the casing and/or by use of a narrow probe. When the rest button is pressed, the controller 16 transmits a global scan message, repeated at 10s intervals over a period of 60s, and waits for a response containing a responder identity signal, from every responder 18 within range. The controller 16 includes a memory store in which it stores each received responder identity. Assuming the controller 16 receives at least one valid responder identity signal then, after 60s, a green LED on the controller is turned on. (If no valid responder identity signal has been received, a red LED is turned on to indicate an error, whereupon the system can be checked and reset again.) To verify each identified responder 18, the controller 16 then transmits a specific status request message to each in turn and demands a valid response (determined by preprogrammed data identifying the controller 16 and the corresponding responders 18). These responses are then stored by the controller 16 in a status array held in SRAM memory.

The panel 36 (Figure 2) includes a switch-on button which, when pressed, causes the controller 16 first to transmit a global switch-on command including the controller's identity signal. The global switch-on command is repeated four times at 0.1s intervals and is followed by a status signal request addressed in turn to each of the responders 18 recorded with the controller 16. Each responder 18 transmits a status request response back to the controller 16, and if this is valid

and correct the controller updates the corresponding status array record. If any response indicates that a responder 18 is in the wrong state (that is, with the apparatus it controls off instead of on), the controller 16 transmits a specific switch-on command to that responder. If necessary, the specific switch-on command is repeated five times, and if the responder concerned does not send back an acknowledgment the controller records that responder as faulty in the status array.

The panel 36 (Figure 2) also includes a switch-off button which, when pressed, causes the controller 16 first to transmit a global switch-off command and initiates a procedure otherwise similar to that described above in relation to the switch-on button.

The computer interface 42 (Figure 2) allows responders 18 to be programmed in various ways. For instance, a group of responders 18 may be specifically associated with a particular controller 16, by storing their respective identities in the controller's memory store, thereby allowing the system to be partitioned into zones (by location, function or whatever). This facility also helps to ensure that neighbouring systems will not interfere with one another. The computer interface may also be use to enable or disable repeater means in the responders, which repeater means cause the responders to retransmit control signals they receive, to extend the range of the system. (Those skilled in the science will appreciate that a system including a large number of responders could generate an excess of overlapping signals unless some repeater means are

disabled. The computer interface 42 may include security features such as password control, and it also allows the system to be operatively connected to a building management system or other computer-based system.

A responder 18 may be arranged to switch emergency lighting on or off depending on signals received from a power failure sensor. The circuitry is shown in Figure 3 and comprises an emergency light 50, an emergency lighting switch 52, a battery 54 and a generator 56 connected by way of a charging unit 58.

To adjust fluorescent lighting, a responder 18 may also include two operational amplifiers providing an DIS protocol interface to a digital dimmable ballast for the lighting unit. Signals received by the responder 18 include a light level code (between 0 and 255) which is processed by the microcontroller 24 (Figure 1) and converted to digital information in the so-called Manchester code. The microcontroller can also be arranged to convert the linear light level information to logarithmic values, whereby the output from the light unit is perceived as substantially linear.

Lighting control may be further adapted by including in the controller 16 a light-dependent resistor connected to the transceiver 22 by way of an analogue-to-digital converter. By this adaptation ambient light level is monitored and a light level code is transmitted to responders 18 arranged to control lighting units accordingly. Thus artificial light can be increased as ambient light levels fall, or decreased as ambient light levels rise.

A PIR/microwave motion sensor may be provided so that the system switches lights on when people are present and switches them off again when they leave.

Lighting for a large area may also be adjusted by a single manually operable controller 16. This may include a rotary control and means to set maximum and minimum light levels. An override switch may be provided to deliver maximum light level, regardless of other adjustment or the effect of any PIR or other sensors in the system, for example to deal with emergencies.

A controller 16 may be associated with a power failure sensor 60, as illustrated for three-phase supply in Figure 4. When mains power is present, relays 62, 64 and 66 respectively associated with the three phases are all closed, so that the connection between terminals 60a and 60b is a short circuit. An interruption in *any* phase causes the respective relay to open. The open circuit is detected by the microcontroller 24 (Figure 1) and this in turn causes a power failure signal to be transmitted to responders associated with emergency lighting units. It is to be understood that this arrangement requires a mains-independent source of power and therefore includes a rechargeable 9V battery and charger circuit, not shown. The sensing circuit may alternatively be wired with the relays 62, 64 and 66 in parallel so that the system operates (eg to turn on emergency lighting) only when all three phases fail.

Various modifications and adaptations of the system as described may be made without departing from the essence of the invention.

CLAIMS

1 A system for controlling electrical apparatus remotely in response to changes of a variable, which system comprises a sensor to sense the variable, a controller operatively associated with the sensor and including a radio transceiver operative to transmit a control signal when the variable changes and to transmit and receive system management signals, and a responder arranged remote from the transmitter and including a radio transceiver operative to receive the control signal and to receive and transmit system management signals.

2 A system for controlling electrical apparatus remotely as claimed in Claim 1 wherein the sensor senses the presence or absence of users of the apparatus.

3 A system for controlling electrical apparatus remotely as claimed in Claim 2 wherein the variable comprises an output from an intruder alarm for premises containing the apparatus.

4 A system for controlling electrical apparatus remotely as claimed in Claim 1 wherein the variable is a natural variable.

5 A system for controlling electrical apparatus remotely as claimed in Claim 3 wherein the apparatus is electrical heating apparatus and the variable is ambient temperature.

6 A system for controlling electrical apparatus remotely as claimed in Claim 3 wherein the apparatus is electrical lighting apparatus.

7 A system for controlling electrical apparatus remotely as claimed in Claim 6 wherein the sensor senses electrical mains power and the electrical lighting apparatus comprises emergency lighting arranged to be turned on if the electrical mains power fails.

8 A system for controlling electrical apparatus remotely as claimed in Claim 6 wherein the electrical lighting apparatus comprises a fluorescent unit including a dimmable ballast operatively associated with the responder and adjustable thereby.

9 A system for controlling electrical apparatus remotely as claimed in Claim 8 wherein adjustment of the dimmable ballast by the responder is such that the perceived output of the fluorescent unit varies substantially linearly.

10 A system for controlling electrical apparatus remotely as claimed in any of Claims 6 to 8 wherein the sensor senses ambient light level.

11 A system for controlling electrical apparatus remotely as claimed in any preceding claim including a plurality of said responders.

12 A system for controlling electrical apparatus remotely as claimed in Claim 11 wherein a responder comprises a repeater for the control signal.

13 A system for controlling electrical apparatus remotely as claimed in any preceding claim wherein the system management signals include identity signals transmitted by the or each transponder and received by the controller.

14 A system for controlling electrical apparatus remotely as claimed in Claim 13 wherein the controller includes a status array recording the proper status of a plurality of said responders.

15 A system for controlling electrical apparatus remotely as claimed in Claim 14 wherein the controller includes reset means operative to check the actual status of each responder against the recorded status and to indicate any discrepancy.

16 A system for controlling electrical apparatus remotely as claimed in Claim 14 wherein the controller is operative to switch controlled apparatus on and off alternatively by transmitting a global switch control signal associated with responder identity signals followed by status request signals to the responders seriatim.

17 A system for controlling electrical apparatus remotely as claimed in Claim 16 wherein each responder responds to the status request signal by transmitting an actual status signal for receipt by the controller and comparison with the record in the status array.

18 A system for controlling electrical apparatus remotely as claimed in Claim 17 wherein, if for any responder there is a discrepancy between the actual status and the record, the controller transmits a correction signal to that responder.

19 A system for controlling electrical apparatus remotely as claimed in Claim 18 wherein the corrected controller transmits a confirmation signal to the

controller when it is corrected, failing which the controller records the responder as faulty.

20 A system for controlling electrical apparatus remotely as claimed in any preceding claim 14 including a computer interface.

21 A system for controlling electrical apparatus remotely as claimed in Claim 20 wherein the computer interface is arranged to enable any responder to be specifically responsive to a defined controller.

22 A system for controlling electrical apparatus remotely as claimed in Claim 21 wherein the computer interface is arranged to allow the system to be partitioned into zones.

23 A system for controlling electrical apparatus remotely as claimed in any of Claims 20 to 22 wherein the computer interface is arranged to allow a responder to be given an individual feature.

24 A system for controlling electrical apparatus remotely as claimed in Claim 20 wherein the computer provides an operative connection between the system and a building management system.

25 A system for controlling electrical apparatus remotely as claimed in any preceding claim wherein the radio transceiver of the controller is the same as the radio transceiver of the or each responder.

26 A system for controlling electrical apparatus remotely substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

ABSTRACT

ENERGY SAVING

A system for controlling electrical apparatus remotely is arranged to control lights 12 in a room 10 automatically in response to a PIR sensor 14 detecting the presence of people. When this happens, a controller 16 associated with the sensor 14 transmits a radio-frequency control signal. The control signal is received by a responder 18 associated with each light 12 and causes a switch in the power supply to the lights 12 to closed automatically and switch them on. When the detected person leaves the corridor 10, the lights 12 are automatically switched off. The controller 16 includes a radio transceiver operative to transmit the control signal and to transmit and receive system management signals and the responders 18 each include a similar transceiver operative to receive the control signal and to receive and transmit the system management signals. Apparatus other than lights may be controlled by the system.

[Use Figure 1]

Fig 1

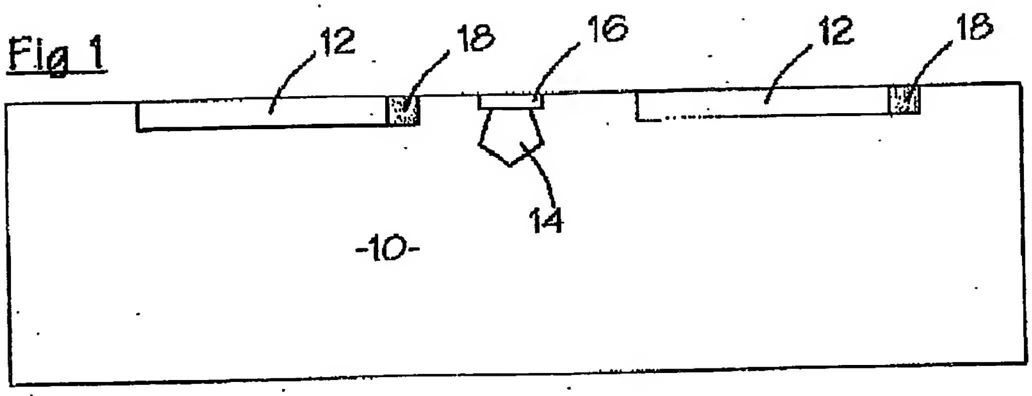

Fig 2

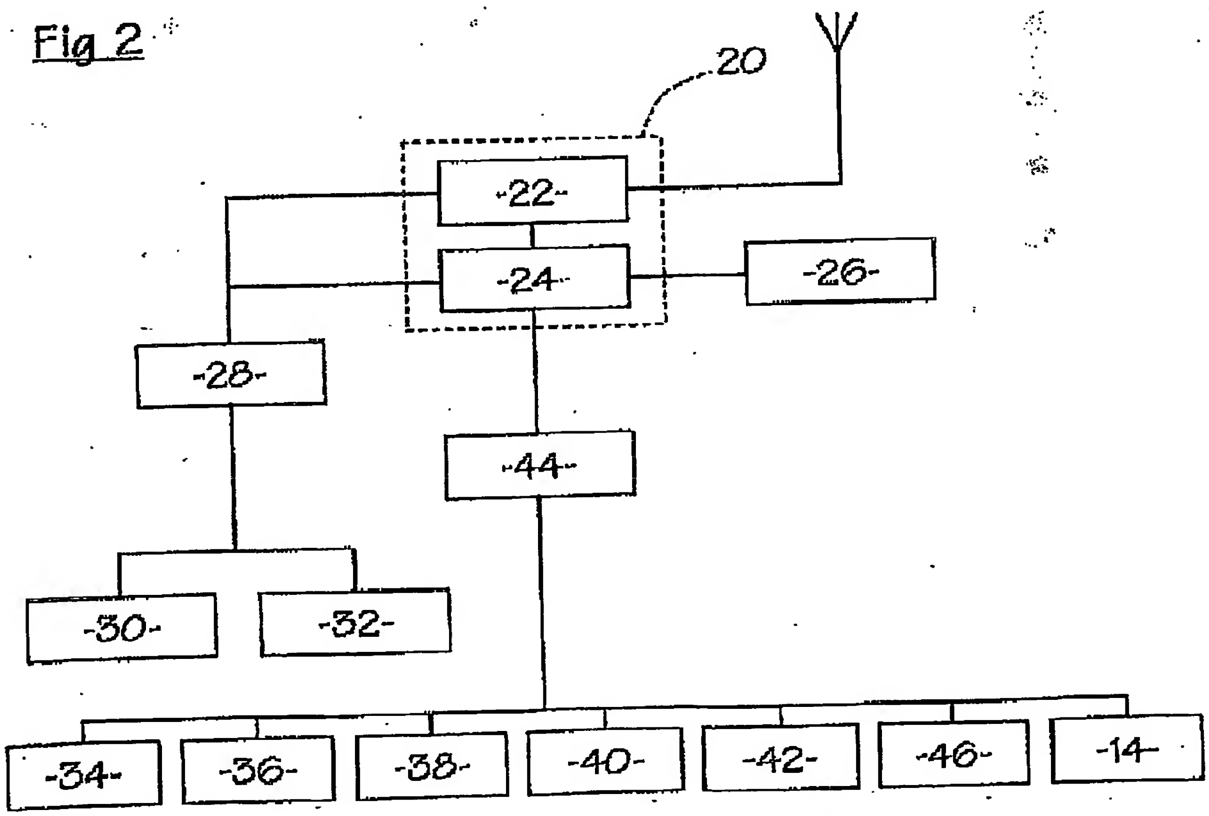

Fig 3

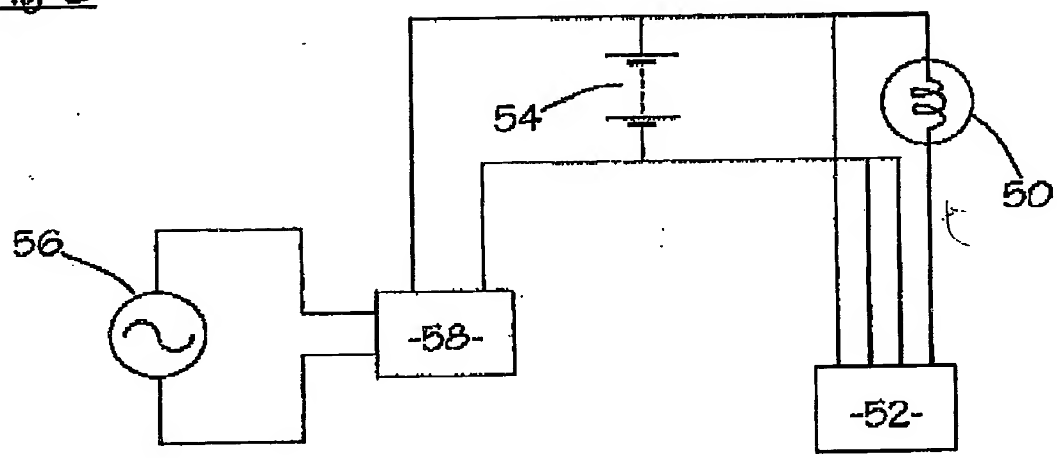
54
50
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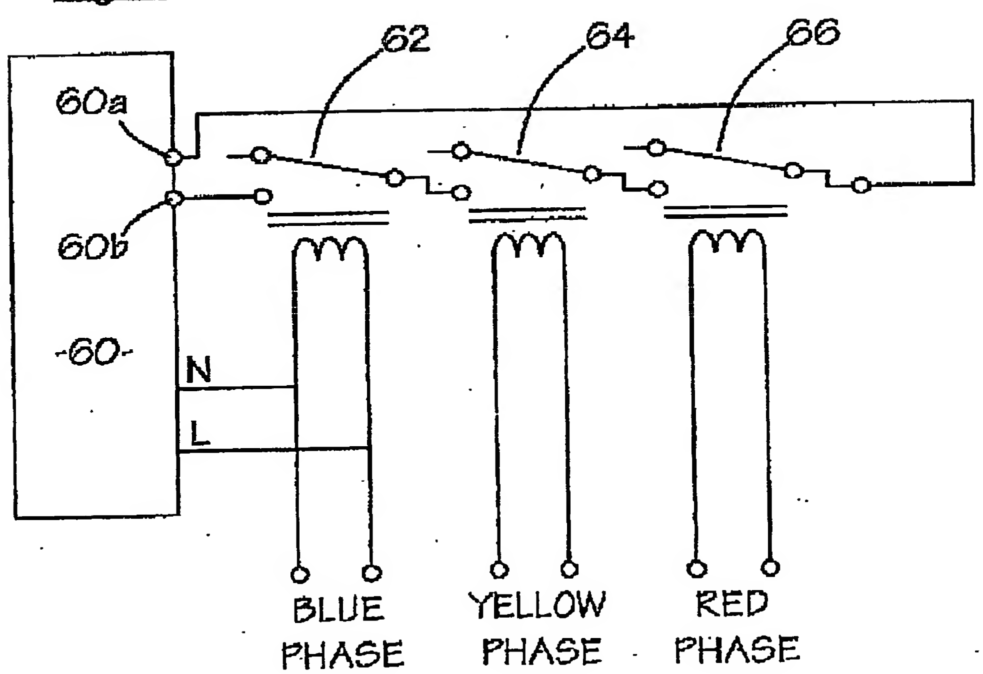
Fig 4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BLUE PHASE
YELLOW PHASE
RED PHASE

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